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Environmental Impact Assessment of Land Use Planning Based on Ecosystem Services Valuation in Xingguo County

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Abstract

This paper describes a case study of environmental impact assessment for land use planning (2006-2020) based on ecosystem services valuation in Xingguo County. The results from the study are as follows. In addition to the decline of ecosystem services valuation of water and unused land during the planning period in Xingguo County, the other various land use types are increasing. The rising range of fields is 61.49% which is the biggest rising range. The new program of land use planning carried out will make the ecosystem services valuation of other types of land use rise from 5.815 billion yuan in 2006 to 5.833 billion yuan in 2020 in Xingguo County, with a net increase of 18million yuan. The valuation of ecosystem services per capita decreases from 7,958 yuan in 2006 to 6,598 yuan in 2020. All of these results indicate that as the population growing continuously, the valuation of ecosystem services per capita relative to the total valuation of ecosystem services shows a negative growth trend. If the valuation of ecosystem services per capita is required to keep bigger or equal to the status quo, the land planning scheme should be further refined and modified.

*Keywords:*Land use planning; ecosystem services valuation; EIA; Xingguo County

1. Introduction

With the rapid development of cities and towns and the acceleration of industrialization, eco-environment problems caused by regional land use changes appear increasingly marked. Land use /land cover change will inevitably cause changes in the structure and function of natural ecosystem [1, 2]. Unreasonable land use will damage the normal ecosystem and reduce the welfare of mankind. Scientific and rational land use planning is about the future control and direction on using land. Land, as the generic terms of variety of terrestrial ecosystems, changes of land use structure will bring variation on types, size

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and spatial distribution pattern of ecosystem. Aiming at economic benefits, the rectifications on land use structure will make the rate of area of ecosystem smaller and smaller in it. On the contrary, the land use proportion of mining, transport and construction in artificial systems will continue to rise. Deterioration of the natural environment restricted the development of economic and caused the dual delay on Economy and ecology. Therefore, the formulation of land use plan should be evaluated in strategic environmental assessment (SEA) to ensure its scientificity.

The ecosystem contribution to human could be measured by economic valuation, and we can affix the economic price tag to the service by means of monetizing the functions and efficiency of ecological. American ecologists Costanza and his fellows introduced a kind of method on measuring the valuation of the global ecosystem service, whose study shows definitely on the principles and methods of accounting ecosystem service valuation by scientific way [3]. The reasons are these two; firstly, the influence on ecosystem of land use could be reflected by economic accounting of ecosystem services valuation. Secondly, land use plan could make influence on ecological functions of ecosystems including forest, grassland and farm by way of influencing land use. By accounting ecology economic valuation to measure ecosystem services valuation and constitution under different land use region, we could obtain the emphasis of the changes of land use structure and also we may read the services valuation provided by varied regional ecosystem under different land use structure. It could be a very good supplementary and auxiliary to comprehensive multi-index evaluation to bring forward suggestions and advice on reorienting land use structure direction. Environmental Impact Assessment (EIA) of land use planning plays a vital role in revealing potential effects of the implementation of land use planning on the eco-environment.

2. Description of the study area

In this paper, a case study was conducted in the Xingguo County, Jiangxi province, typical red soil hill zone of 3210 km^2, it is bounded by coordinates of 115 ° 01'~ 115 °51' E, 26 ° 03'~ 26 ° 42 'N, located southern in Jiangxi province. The average elevation is 130-1200 m. It belongs to subtropical monsoon moist climate and average annual rainfall is 1500 mm. Annual average temperature is 18.9℃. Accumulative temperature (≥10℃) is around 6029.9℃. Frostless season is around 280-300days. Main geomorphological types in the Xingguo county has valley alluvial plain, red soil downland, red sandstone purple shale hilly and granite metamorphic rock mountain. Main soil type in the Xingguo County is red soil.

3. Approach and method

3.1. Data resources

The basic data derives from Statistical Yearbook of Xingguo County, Statistical Yearbook of the land use of Xingguo County, the evaluation on land use planning and implementation of Xingguo County, the program of general land use planning from 2006 to 2020.

3.2. Approaches for assessing ecosystem services valuation

We may define Ecosystem services valuation like this, Ecosystem services valuation is a kind of natural environment or utility we live by, which is formed and maintained by ecosystem and its ecological processes, and by means of ecosystem service function we obtain products and services directly or indirectly from it [4]. Approaches for assessing ecosystem services valuation nowadays presented are ecosystem services valuation coefficient estimation method, direct market valuation method and non-market evaluation method based on the contingent valuation method [5]. This paper calculates the ecosystem services valuation in Xingguo County by using Costanza's equation of ecosystem services

valuation (Equation 1), consulting and adjusting the coefficient of ecosystem services valuation of the unit area of different types of land use in Fujian Province which is estimated by Yao Chengsheng [6].

$$V_j = \sum_{i=1}^{n} (A_i \cdot VC_i) \quad (1)$$

where V_j is the estimated ecosystem services valuation, A_i is the area(hm^2)and VC_i is the valuation coefficient(Yuan/（hm^2·a）)for land use category 'i' (Table I).

TABLE I. COFEFICIENT OF THE ECOSYSTEM SERVICES VALUATION Yuan/hm^2·a

Land use type	*farmland*	*garden plot*	*forestry*	*Settlement*	*water area*	*Unused land*
Coefficient	6831	6831	21599	0	53715	415

The formula to compute the specific annual ecosystem services valuation of land use type and increment in planning years relative to the benchmark year is as follow:

$$\Delta V_j = V_j - V_0 \quad (2)$$

Where V_j is total ecosystem service function economic valuation of the jth year for research area; V_0 is the total ecosystem service function economic valuation of datum year for research area; $\triangle V_j$ is the ecosystem service function economic valuation fluctuation of the jth year relative to datum year.

4. Results and discussion

4.1. Changed area of each land use ecosystem in planning period

Land use plan affects the ecological environment through its influence on land use, so we classify ecosystem types according to the differences among Methods of using land. Consulting formerly studied, we divide the ecosystem in Xingguo County into the farming land, the fields, the forest land, the grassland, the construction land, the water area and other land ecosystem. According to the Change of area and the area of each land use ecosystem of Xingguo from 2006 to 2020, we obtain each kind of land use ecosystem area and the change (Table II).

TABLE II. AREA CHANGES OF EACH LAND USE ECOSYSTEM FROM 2006 TO 2020 IN XINGGUO COUNTY (hm^2, %)

		Farming land	*Field*	*Forest land*	*Grassland*	*Water*	*Construction land*	*Other land types*
Area	2006	33310	4632	245958	0	4393	14721	17920
	2010	34227	5673	246053	0	4271	15007	15702
	2020	34867	7480	246087	0	4149	15587	12764
2006~2020	***change***	1557	2848	129	0	-244	866	-5156
	Rate	4.67	61.49	0.05	\	-5.55	5.88	-28.77
	Ratio	0.31	4.10	0.003	\	-0.37	0.39	-1.92
2006~2010	***Change***	917	1041	95	0	-122	866	-2218
	Rate	2.75	2.25	0.04	\	-2.78	5.88	-12.38
	Ratio	0.55	0.45	0.008	\	-0.56	1.18	-2.48
2010~2020	***Change***	640	1807	34	0	-122	580	-2938

	Rate	1.87	31.85	0.01	\	-2.85	3.86	-18.71
	Ratio	0.17	2.90	0.001	\	-0.26	0.35	-1.70

The goal of land planning is to make the way of land use more intensive under the circumstance of protecting ecological environment; make the structure and distribution of land use to be further improved; and maintain the total dynamical equilibrium of farmland quantity, ensure the economic result, the social efficiency and the ecological benefit of land use get marked achievement. During the planning period, the field ecosystem area will get obvious increases, it will increase from 4632 hm^2 in 2006 to 7480 hm^2 in 2020, forest land ecosystem area will maintain less change. The change of land ecosystem will concentrate on transformation from unused land to the farming land and the field.

4.2. Dynamic changes of ecosystem services valuation for each land use category and total ecosystem services valuations

By using Equation 1 and the coefficients in Table I, we get ecosystem services valuation for each land use type and total ecosystem services valuations in Xingguo county (Table III).

What we can see in Table III are that the implementation of new round land use plan in Xingguo County will cause the total ecosystem service function valuation slight escalation, such as from 58.15×108 Yuan in 2006 to 58.33×108 Yuan in 2020, with an increase of 0.18×10^8 Yuan. The changes of ecosystem services valuation of each land use in Xingguo County during three analysis period are positive, except the water area and unused land all the other type of ecosystem services valuation are on the rise. Among these, the field amplification degree is the biggest, is 61.49%; however the unused land is on the contrary, the rates are -28.77%, - 12.38%, - 18.71% during three analysis period, the biggest absolute increasing valuation is the field, it's about 0.195×10^8 Yuan, And the biggest absolute reducing valuation is the water area, it's about 0.131×10^8 Yuan. It indicated that the increase of field ecosystem services valuation is the primary factor to ensure the increases of total ecosystem services valuation in Xingguo. If we assess this plan from the angle of ecosystem services valuation, this plan is reasonable, it's helpful for improving the ecological benefit.

TABLE III. CHANGES OF ECOSYSTEM SERVICES VALUATION FOR EACH LAND USE TYPE AND TOTAL ECOSYSTEM SERVICES VALUATIONS IN XINGGUO COUNTY ($\times10^8$yuan, %)

		Farming land	***Field***	***Forest land***	***Grassland***	***Water***	***Unused land***	***Total***
Ecosystem services valuation	2006	2.275	0.316	53.124	0	2.360	0.074	58.149
	2010	2.338	0.388	53.145	0	2.294	0.065	58.23
	2020	2.382	0.511	53.152	0	2.229	0.053	58.327
2006~2020	***change***	0.106	0.195	0.028	0	-0.131	-0.021	0.177
	Rate	4.67	61.49	0.05	\	-5.55	-28.77	31.89
	Ratio	0.31	4.1	0.003	\	-0.37	-1.92	2.123
2006~2010	***Change***	0.063	0.071	0.021	0	-0.066	-0.009	0.08
	Rate	2.75	2.25	0.04	\	-2.78	-12.38	-10.12
	Ratio	0.55	0.45	0.008	\	-0.56	-2.48	-2.032
2010~2020	***Change***	0.044	0.123	0.007	0	-0.065	-0.012	0.097
	Rate	1.87	31.85	0.01	\	-2.85	-18.71	12.17
	Ratio	0.17	2.9	0.001	\	-0.26	-1.7	1.111

TABLE IV. CHANGES OF ECOSYSTEM SERVICES VALUATION PER CAPITA IN XINGGUOCOUNTY (Yuan /per capita, %)

		Farming land	*Field*	*Forest land*	*Grassland*	*Water*	*Unused land*	*Total*
Ecosystem services valuation	2006	311.35	43.25	7270.23	0	322.98	10.13	7958
	2010	298.29	49.5	6780.43	0	292.68	8.29	7429
	2020	269.49	57.81	6013.35	0	252.18	6.00	6599
2006~2020	***change***	-41.86	14.56	-1256.88	0	-70.80	-4.13	-1359
	Rate	13.45	33.67	-17.23	\	-21.92	-40.77	-32.86
	Ratio	-0.90	2.24	-1.15	\	-1.46	-2.72	-3.98
2006~2010	***Change***	-13.06	6.25	-489.8	0	-30.3	-1.84	-529
	Rate	-4.20	14.45	-6.74	\	-9.38	-18.16	-24.03
	Ratio	-0.84	2.89	-1.35	\	-1.88	-3.63	-4.81
2010~2020	***Change***	-28.8	8.31	-767.08	0	-40.5	-2.29	-830
	Rate	-9.66	16.79	-11.31	\	-13.84	-27.62	-45.64
	Ratio	-0.97	1.68	-1.13	\	-1.38	-2.76	-4.56

4.3. Dynamic change of ecosystem services valuation per capita in planning period

The ecosystem service aims at servicing to humanity, and its final beneficiary of ecosystem service is humanity. Therefore, it's necessary to compute ecosystem services valuation per capita during the parsing process. The ecosystem services valuation per capita takes the factor of population growth into account, to compare with the total ecosystem services valuations, so valuation of average per capita can reflect the influence to the humanity result from the ecological environment the change truly. The ecosystem services valuation per capita in Xingguo county are in table 4, the population data in 2006 and 2010 derived from Statistical Yearbook of Xingguo County, and the population in 2020 is calculated according to the last 10 year average rate of natural population growth.

In Table IV we may see that, during planning period, the Change of ecosystem services valuation per capita and the total services valuations in three analysis intervals assume the opposite changing tendency. The ecosystem services valuation per capita drops from 7958 Yuan in 2006 to 6598 Yuan in 2020. Except the field all the other land type service valuation assumes negative growth. So the implementation of the land use planning may improve total ecosystem service valuation for Xingguo County, but as a result of the population growth, the ecosystem services valuation per capita and the ecology land area are cut down, ecological environment construction can't catch up with population growth speed in Xingguo county, in order to maintain ecosystem services valuation per capita not lower than the early stages of the plan, we should make further revision and consummation on this plan.

4.4. Suggestions

As a manifestation of SEIA, the ultimate stay point of environmental impact assessment of the general land use planning is to puts forward measures to lessen the disadvantageous environmental effects and increases advantageous ones. Based on the result of environmental impact assessment of the general land use planning, this article proposed measures as follows.

1) *Ensuring the ordering of land use structure, executing land use control strictly, and arranging ecological land use reasonably:* Executing land use control strictly, making full use of the regulatory effect of land use, is an important way to realize coordinated development between land use and ecological environment. With respect to land use, what we need is to control the area of construction land and farming land sternly, also we should arrange the ecology land positively. And on the part of layout, we should take the arrangement of ecological land in ecological fragile region seriously. And we should improve the rate of ecology land area; carry on the rational distribution on land use category during the construction period of Xingguo County too.

2) More research on ecological environmental, grasping the changes in time: To achieve scientific management and reflect the changes of the environment accurately, we should grasp the present changing situations of ecological and environmental problems based on pre-existing information on soil erosion and geological disasters; enhance monitoring strength; establish early warning mechanism; improve the capability of defending against disaster and dealing with ecological problems; heighten monitoring and early warning tools, such as building an ecological problems database, using GIS and other means and so on.

3) Scientifically formulating and strictly implementing the relevant plan: To develop a scientific planning of spatial arrangement such as general land use planning, town planning, industrial distribution planning and so on, make the planning for economic development activities in a reasonable range. Enhance soil erosion control planning and geological disaster prevention planning, forest planning and special programs, and actively develop and highlight solutions or prevention program to deal with various ecological problems. Simultaneously, planning and reasonable measures must be strictly implemented to achieve economic ecological environmental development goals.

5. Conclusions

Except a decrease in ecosystem services valuations of water area and unused land, the ecosystem services valuations of other land use types are indicated to be a rising trend with the largest amplification of 61.49% on field in Xingguo County during the planning period.

Total ecosystem service function valuation increased from 58.15×10^8yuan in 2006 to 58.33×10^8yuan in 2020 indicates that it is to a smoothly rising trend by the implementing of a new round of land use planning program in Xingguo County.

The decrease of per-capita ecosystem services valuation from 7957 yuan in 2006 to 6598 yuan in 2020 means that per capita ecosystem services valuation is negative relative to the rising trend of total ecosystem services valuations with the continuously increasing of population.

If per capita ecosystem services valuation is expected to remain at a current level, we should take some steps below: Planning program should be perfected and altered, collocate and optimize the regional land use structure. Strictly control the changing of land uses types with higher ecosystem services valuation to others with lower ecosystem services valuation in order to remain the ecosystem healthy.

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References

[1] C. H LU and K. J. Jia, “Indicators for assessing the ecological and environmental effects of integrated land use planning and their application to a case study,” Geographical Research, vol.26, pp. 249-257, 2007. （in Chinese）

[2] H. L. Xie, X. B. Li, et al, “Environmental Impacts of Land Use Planning Based on an Ecological Security Method in Ongniud Banner, Inner Mongolia”, Resources Science, vol.32, pp. 57-63, 2010 (in Chinese)

[3] R. Costanza, R. d’Arge, R. de Groot, et al, “The value of the world’s ecosystem services and nature,” Nature, vol.387, pp. 253-260, 1997.

[4] J. H. Dong, C. K. Bao and D. H. Jiang, “Technical Methods of Environmental Impact Assessment for Land Use Planning”, Sichuan Environment, vol.25, pp. 50-54, 2006 (in Chinese)

[5] H. L. XIE, Theory, method and practice for environmental influence assessment of land use planning, Economical Science press, 2009. （in Chinese）

[6] C. S. Yao, H. J. Zhu, et al, “Study on the Impact of Social economic Driving Factors of Land Use Change on the Ecosystem Service Values in Fujian Province”, Journal of Natural Resources, vol.24, pp. 225-233, 2009 (in Chinese)